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Final Report--Objective E, Task 1

December 1987

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A REMOTE ACTION INVESTIGATION WITH MARINE ANIMALS

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SRI International

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Covering the Period 1 October 1986 to 30 September 1987

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SRI Project 1291

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ABSTRACT

In FY 1986, SRI International awarded a subcontract to the College of Marine Studies of the University of Delaware to conduct remote action (RA) experiments using marine algae as target elements. Protocols were developed during that year that would enable SRI to test, with a living system, the Intuitive Data Sorting model. During FY 1987, significant improvement was made to stabilize the data so that standard analysis techniques (e.g., ANOVA) might be used. While much progress was made toward that end, significant autocorrelations persist. Nonetheless, an attempt was made to generate successful RA. SRI analyzed data for four participants and found no statistical evidence of RA.

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I INTRODUCTION

For a number of years, Dr. C. M. Pleass of the College of Marine Studies at the University of Delaware, has been constructing a remote action (RA) experiment using various species of marine algae as targets. In these types of experiments, RA participants attempt to change the swimming velocities of single algae cells during effort periods as compared to control periods.

Encouraged by a paper presented at an annual meeting of the Parapsychological Association,[1*] SRI International awarded a two-year contract to the University of Delaware to satisfy Objective E, Task 1 of the FY 1986 statement of work. For the first year, the task was to stabilize the equipment and protocol, while the task for the second year was to collect RA data. This report describes SRI's role in that effort and summarizes the work done by Dr. Pleass.† (The University of Delaware's draft final report is included, verbatim, in the Appendix.)

* References may be found at the end of this report.

† This report constitutes the deliverable for Ojective E, Task 1.

II REVIEW OF THE UNIVERSITY OF DELAWARE REMOTE ACTION PROJECT

In the past, the putative RA data from the College of Marine Studies of the University of Delaware, have been criticized for the statistical methods that were employed. The cell velocity, as a function of time, exhibited an unknown mixture of biological and environmental correlated responses (i.e., the data points were not statistically independent). In a report included in SRI's FY 1986 interim report on this experiment,[2] a significant autocorrelation was observed, yet there was no modification of the statistical analysis to account for the correlation. (The complete FY 1986 results can be found in Reference 2.)

During the first few months of FY 1987, the University of Delaware moved the project to new and better facilities. The move delayed our joint FY 1987 project; however, as is shown below, a major improvement of data stability was realized.

Initially, the experimental setup in the new location was identical to the old, but with the following improvements:

- The floor of the new laboratory is a 3-foot thick concrete slab. This improved the physical isolation of the apparatus.
- The apparatus was installed in an electrically isolated and sound attenuated room.
- It was now possible to collect data for 24-hour periods.

SRI personnel inspected the new facilities and found them to be significantly improved. What follows is a description of the FY 1987 activity.

A. Toward Increased Data Stability

Baseline velocity data were collected over 24 hours for fifteen 24-hour periods. It was clear (see Figure 2 in the Appendix) that the cells exhibited erratic behavior during the "day" (0800 to 1700) but were quiescent between 0000 and 0800. This quiescent period suggested that the organisms might be sensitive to the increased electromagnetic activity during the day and might be less stimulated during the night. (SRI analyzed a quiescent data set and found the data to be normally distributed with a slight tail favoring downward swimming.)

A second possible contribution to the data instability was noticed. The algae cells tended to clump, especially if they had been in the experimental chamber for some time. If this tendency was consistent, it would produce strong autocorrelations in the data.

The solution to the first problem was to attempt to provide better shielding, but it was realized that ELF shielding was not possible. Instead, a completely new experimental chamber was designed.

In the old system, cells, which were drawn once per day from a biostat, constituted a fresh experimental sample daily. While it was good to have fresh cells, the immediate change in environment led to initial instabilities and, in the absence of light and nutrients, the cells lost energy over time. This trend was obvious from the data in that cells showed an increasing tendency to swim with gravity rather than against it.

The new system uses a continuous flow design. Fresh cells flow through an experimental region at an orthogonal (to the measurement axis) velocity of $\sim$150 mm/sec. This change greatly improved the stability, and significantly reduced the clumping.

B. Protocol for Data Collection and Analysis

With the increased stability, it was decided to use two types of analysis:

(1) Standard Analysis of Variance (ANOVA).

(2) Data Analysis sensitive to the Intuitive Data Sorting (IDS) model.

The standard ANOVA 2 x n consists of a design where n is the number of consecutive temporal data samples collected in each of the effort and control conditions. The IDS analysis was outlined earlier,[2] and a complete description can be found in SRI's final report on Objective E, Tasks 3 and 4.[3]

Briefly, the IDS formalism uses a simple application of the central limit theorem to show that for mean chance expectation (MCE), the expected value of the log of the absolute value of the detrended velocities is linearly related to the log of an averaging length, n. Under RA conditions, the relationship is nonlinear in a dramatic way (Figure 1). Under IDS conditions (i.e., psychoenergetically biasing a sampling distribution) the formalism predicts a linear relationship once again, but with increased intercepts over MCE. The averaging length, n, is defined as the number of samples of the parent velocity distribution that are averaged to form one data point.

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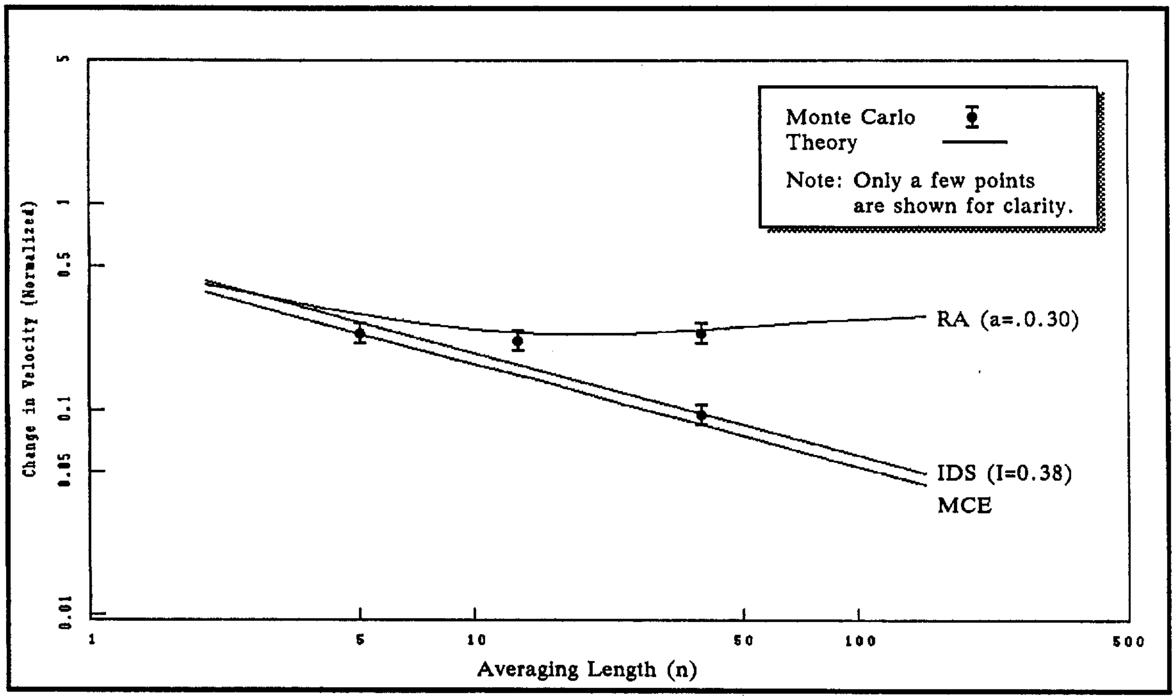

FIGURE 1 RESULTS OF THE IDS AND MONTE CARLO CALCULATIONS

SRI conducted extensive Monte Carlo calculations to simulate the experimental IDS design. The results are shown in Figure 1. The RA curve was calculated assuming a parent distribution shift of 0.3σ--the only free parameter. The IDS curve was calculated assuming that the sampling distribution had an increased variance[2] of 0.38. Only 4 of the 12 generated data points (3 for each model) are shown. All points fell within 1σ (the error bars) of the theoretical curves--an expected result considering that each model has only one specified free parameter.

SRI proposed that 50 trials for each of three averaging lengths (5, 15, and 40) be collected by one RA operator (blind to the averaging length).

Delaware proposed that the actual data collection proceed as much like their "wave" protocol as possible. In a single trial, an operator marks a continuous, but undisplayed velocity data stream when he/she feels that RA has just occurred. This effort period is followed immediately by a control period of length n points. This is followed by a brief, but random, interval before a second identical period to the above couplet is collected as a pseudo-effort period.

In addition to the psychoenergetic trials, SRI requested that a "real" influence be exerted upon the algae under the same collection format described above. The data would be used to

demonstrate that if RA behaved like a "real" influence, the IDS formalism would be capable of describing it.

C. Results

Four operators produced five trials each at each of the three averaging lengths. This raw data and one set of "real" influence (spark stimulus) data simulated for five trials was sent to SRI for analysis.

The "wave" protocol used by the the Delaware group suggested that the ANOVA be changed to a 2 x 2n design. A separate analysis was then performed for each of the averaging lengths. The first row of the ANOVA data matrix consisted of the five-trial averages of the velocity (detrended) for each of n points during the effort period (i.e., just before the operator marks the data stream) and a second set of n control points. The second row was identical to the first row, except the data were taken from the pseudo-effort period.

This particular design was sensitive to the "release-of-effort" wave protocol and to differences between the effort and pseudo-effort periods. The ANOVA was conducted for all three averaging lengths for the four operators and for the spark stimulus data. There was no evidence even suggestive of an extra-chance anomaly.

Delaware made two attempts at simulating RA. The first used spark induced E&M as a perturbing force, however, the intensity was insufficient to produce any effect. Following an SRI suggestion, Delaware used visible light to induce a change in swimming velocity. SRI was unable to confirm a stable velocity shift in the data from this attempt as well.

D. Discussion

Two conditions must be met before an ANOVA is valid. The data must be approximately normal and they must be statistically independent. ANOVA is particularly forgiving for the first condition, but if a positive serial correlation exists, a significant underestimate of the residual variance can result.[4] This can result in an artifactually significant F ratio.

Figure 2 shows a typical velocity distribution with a Gaussian fit and a Gaussian fit with a matched exponential tail. It is clear by inspection and the value of chi-square that the first criterion (approximate normality) is easily met.

The second criterion is much more important from an ANOVA perspective. While the autocorrelation has improved greatly since the earlier report,[2] it nonetheless, still represents a

high degree of significance--especially for the early lags. This can be seen in Figure 3 as low frequency oscillations of the velocity envelope. Even after the significant improvement of the system, some non-random component to the velocity data remains. Because the overall ANOVA result was not significant, and the autocorrelations are all positive, we are not required to calculate the appropriate error residuals for our correlated data.

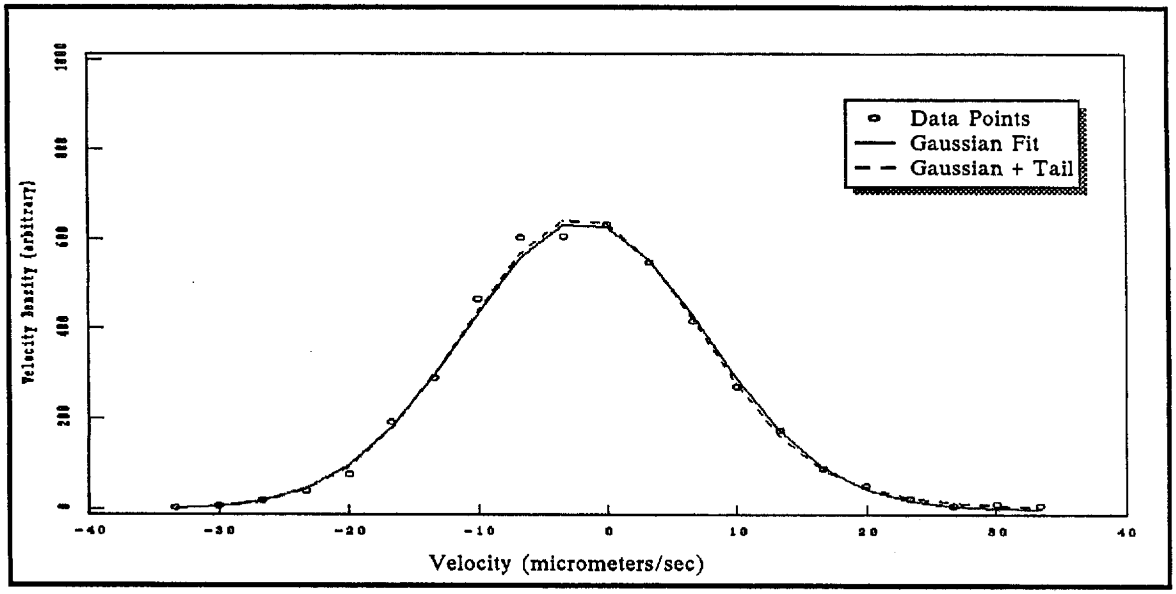

FIGURE 2 POST SESSION CONTROL VELOCITY SPECTRUM -- OPERATOR 48

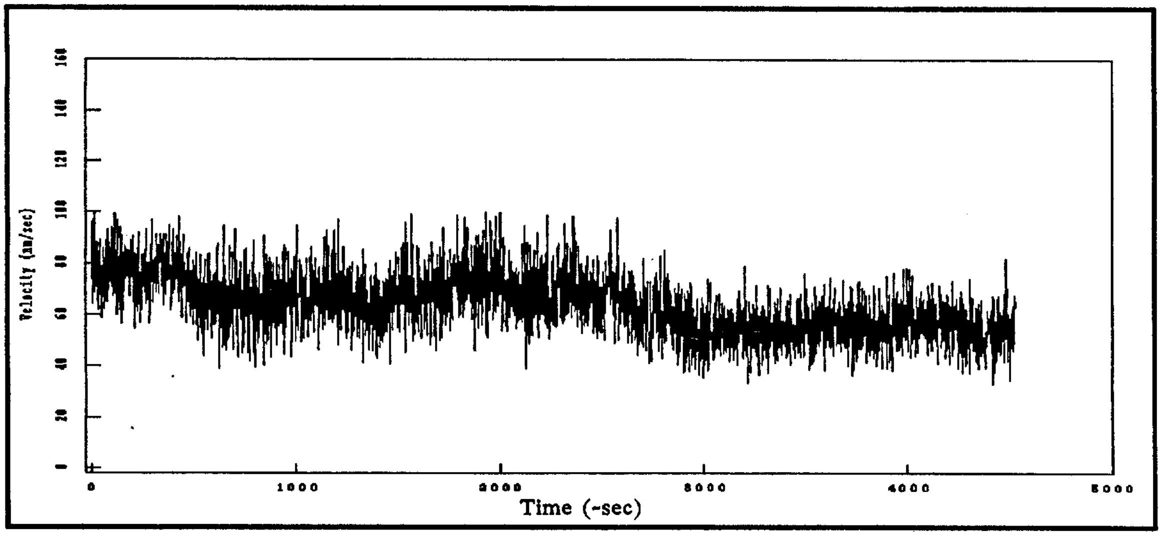

FIGURE 3 POST SESSION CONTROL VELOCITY DATA -- OPERATOR 48

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The Delaware efforts were quite disappointing. SRI designed the protocol and analysis and made numerous suggestions about improving the physical set-up. Virtually all the RA data were collected in the last month of the contract, so that only 5 trials instead of the requested 50 were collected at each averaging length. Second, the operators were *not* blind to the averaging length; thus, even if we had observed significant evidence of an anomaly, we would be unable to interpret it with regard to the IDS model.

Why the RA simulations (spark data) were not significant remains a mystery. Either the wrong stimuli were chosen by Delaware, or the stimulus intensities were incorrect.

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1. Pleass, C. M., and Day, N. D., "Using the Doppler Effect to Study Behavioral Responses of Motile Algae to Psi Stimulus," Proceedings of the 28th Parapsychological Association Convention, pp. 373–406 (August 1985).
2. May, E. C., Humphrey, B. S., and Pleass, C. M., "Measuring Remote Action Influence on the Vertical Component of *Dunaliella* Velocity," Interim Report, Objective E, Task 9, Project 1291, SRI International, Menlo Park, California (December 1986).
3. May, E. C., "Intuitive Data Sorting: An Informational Model of Psychoenergetic Functioning," Final Report, Objective E, Tasks 3 and 4, Project 1291, SRI International, Menlo Park, California (December 1986).
4. Neter, J., Wasserman, W., and Kutner, M. H., *"Applied Linear Statistical Models,"* Second Edition, Homewood, Illinois, Richard D. Irwin, Inc., p. 445 (1985).

APPENDIX

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Final Report on the Stanford Research International Project. "Evaluation of the Theory of Intuitive Data Sorting, and Its Application to Bio Laser Doppler Data Generated by Marine Microorganisms"

Duration: Two Years from 10/1/85

Program Leader: Dr. C. M. Pleass
College of Marine Studies
University of Delaware
Newark, Delaware 19716

The following description is excerpted from the original proposal, so that this final report may be placed in proper perspective:

Year One - 10/1/85 - 9/30/86.

Using the existing Bio Laser Doppler facilities at the Bayside Laboratory, develop a protocol and statistical analytical procedure which can effectively address the question of the validity of the SRI theory known as Intuitive Data Sorting (IDS).

The deliverable, due by 9/30/86, would be a report describing a mutually acceptable experimental and analytical technique. This implies frequent contact with the SRI project monitor throughout the year, as the various options are examined.

Year Two - 10/1/86 - 9/30/87.

Using the protocol and procedure developed in Year 1, to carry out Bio Laser Doppler experiments that address the validity of the IDS theory. This will require the involvement of volunteer participants from the Lewes community, whose task will be to try to intuit or anticipate changes in the statistical parameters describing the motion of marine microorganisms, or in some similar

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way, to provide evidence bearing on the validity of the SRI theory. The individuals involved will not be identified in the report by name, and the appropriate informed consent will be obtained in each case, to meet the University of Delaware's human subject requirements.

The deliverables will be a report containing a description of the detail of each trial, including statistical ensembles that best represent the data, and copies of the floppy discs carrying the raw data.

* * * * * * *

In practice, the project progressed in two cycles, both of which involved program development and experimental psi work. Thus in Year 1, two appropriate psi protocols were developed (pk 85 and WAVE), and volunteers from the Lewes community used them to create data bases which SRI and UD examined together[1]. The experimental and analytical techniques appeared acceptable, a priori, but instability in the baseline time series velocity data threatened the credibility of the results.

Very few segments of our time series records of unstimulated algal movement taken prior to the fall of 1986 were free from some abrupt changes in average velocity and vector. However for practical reasons most of the data had been acquired during the

[1] Algal swimming velocity, resolved along a single axis, constituted the primary experimental variable. The variance of this data and the direction of movement, up or down, were secondary variables.

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working day. This suggested 24-hour time series studies of unstimulated cultures, to examine the possibility that the observed changes were part of a natural circadian rhythm. After modifying the system to allow 24 hour studies, fifteen 24-hour data sets were collected in November - December 1986. On January 13, 1987, Ed May and Peter McNelis of SRI met with Mic Pleass and Dean Dey at Lewes to discuss this data. A typical time series is shown in the fold-out (Fig. 1).

A "window" was clearly evident in all 15 data sets between circa midnight and eight AM. (Fig. 2) The data in this region were quiet and would have formed an acceptable basis for psi experiments. However, it seemed unlikely that participants and experimenters would show much enthusiasm for working through this period.

As a secondary benefit, the data gave us perspective on the hours 0900 - 1500 which include most of our previous psi runs. It seemed clear that this was a period when the algae were generally swimming non-randomly, with quite frequent abrupt changes in average velocity. As we were all aware, this places a heavy stress on the analytical technique and the credibility associated with the data from psi experiments. It is impossible to choose between exogenous or endogenous (circadian) influences when looking for a cause. However, the group were suspicious of sonic and electromagnetic disturbances associated with the working day.

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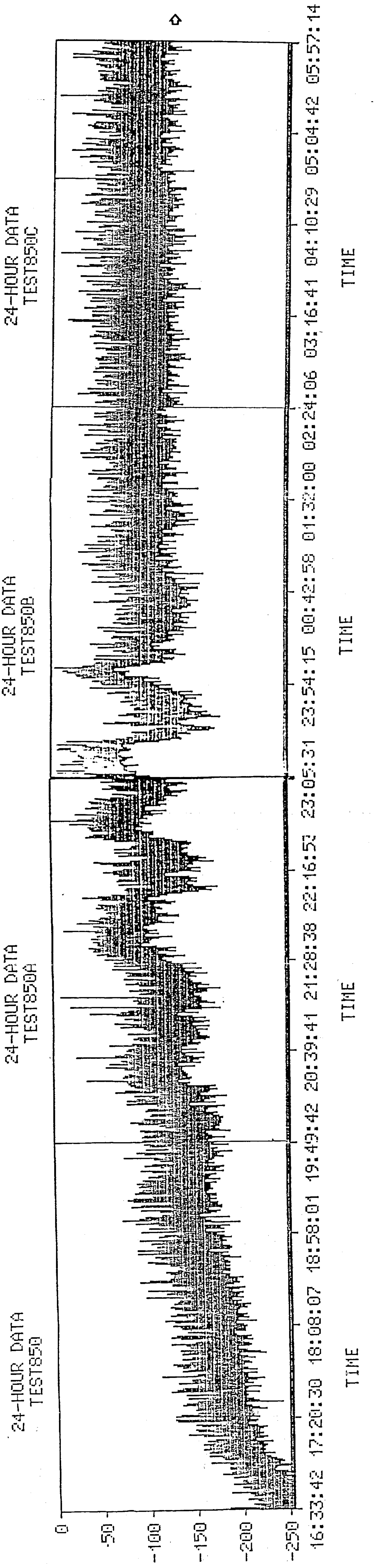

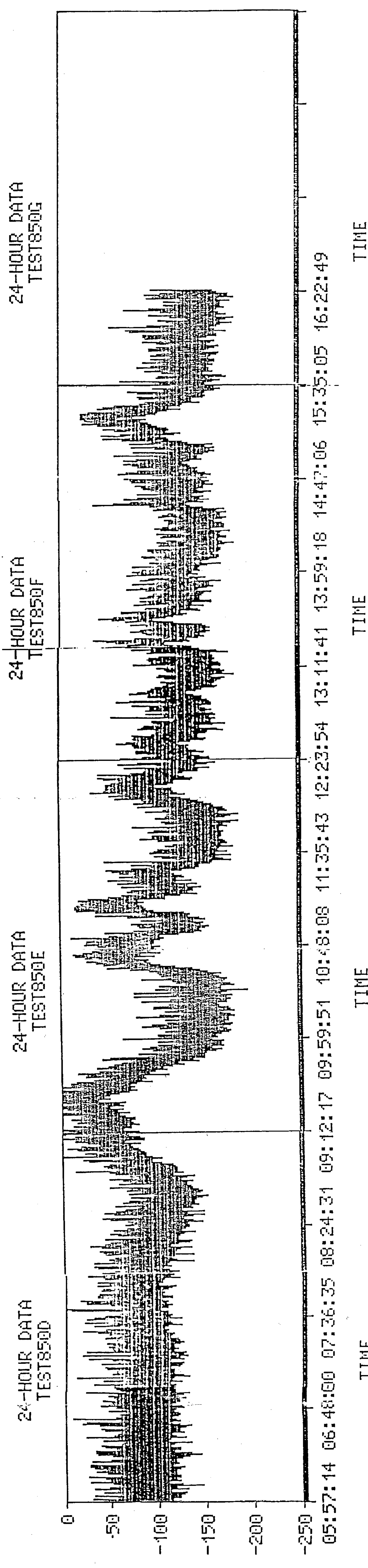

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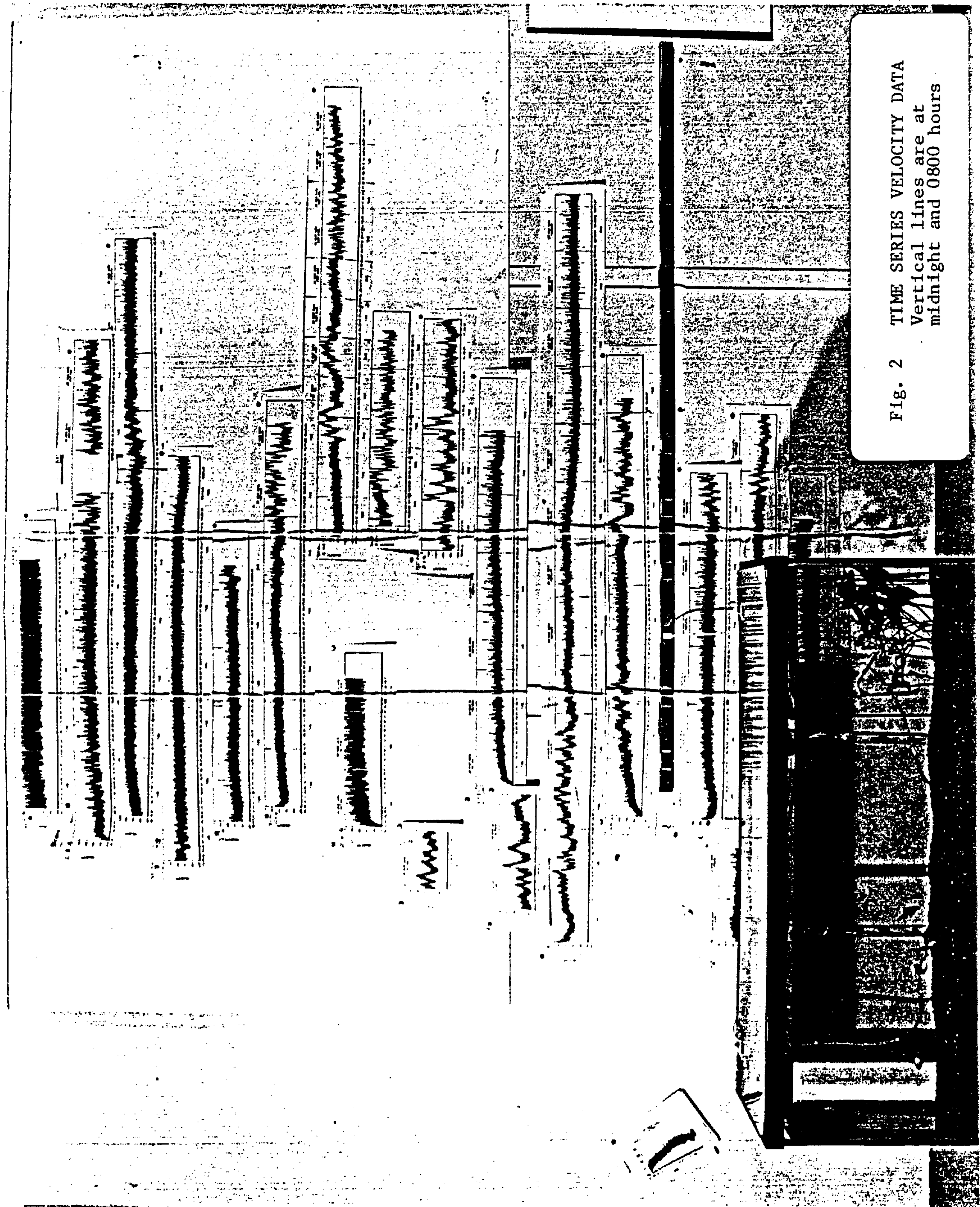

Fig. 2 TIME SERIES VELOCITY DATA
Vertical lines are at
midnight and 0800 hours

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The environmental chamber housing the BLD apparatus was converted into a modestly good RF and sonic quiet room. The results were unchanged. The next step was to actively look for evidence of group dynamic change within the algae in the tissue culture vessel used to hold the sample. By visually observing a particularly hardy clone of Dunaliella which lived for three months on Mic Pleass' office window sill (unnurtured through the period, and knocked over several times!) we were able to identify "micro avalanches" of cells, superimposed on upward and downward movement of the green suspension. Literature search revealed one relevant reference[2] which provided examples of microavalanching in cultures of Dunaliella. This seems to be a natural method of redistributing cells which have physical reasons for normally swimming upward.

To work around this problem a flow system was constructed, so that a well mixed culture from a biostat external to the environmental chamber could move in slow (100-200 $\mu m\ sec^{-1}$) laminar flow past the measuring volume. The virtual fringes of the BLD system were aligned parallel to the flow, ie, the axis along which velocity measurements were made was chosen to be at right angles to the artificially induced flow. Experiments confirmed that these velocity data were unaffected by the slow flow. Twenty-four hour runs appeared much quieter. Ed May visited Lewes again on May 5th, just at the right time to see a very good looking time series

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[2] Kessler, J. O., Cooperative and concentrative phenomena of swimming microorganisms. Contemp. Phys. 1985, Vol. 26, #2, 147-166.

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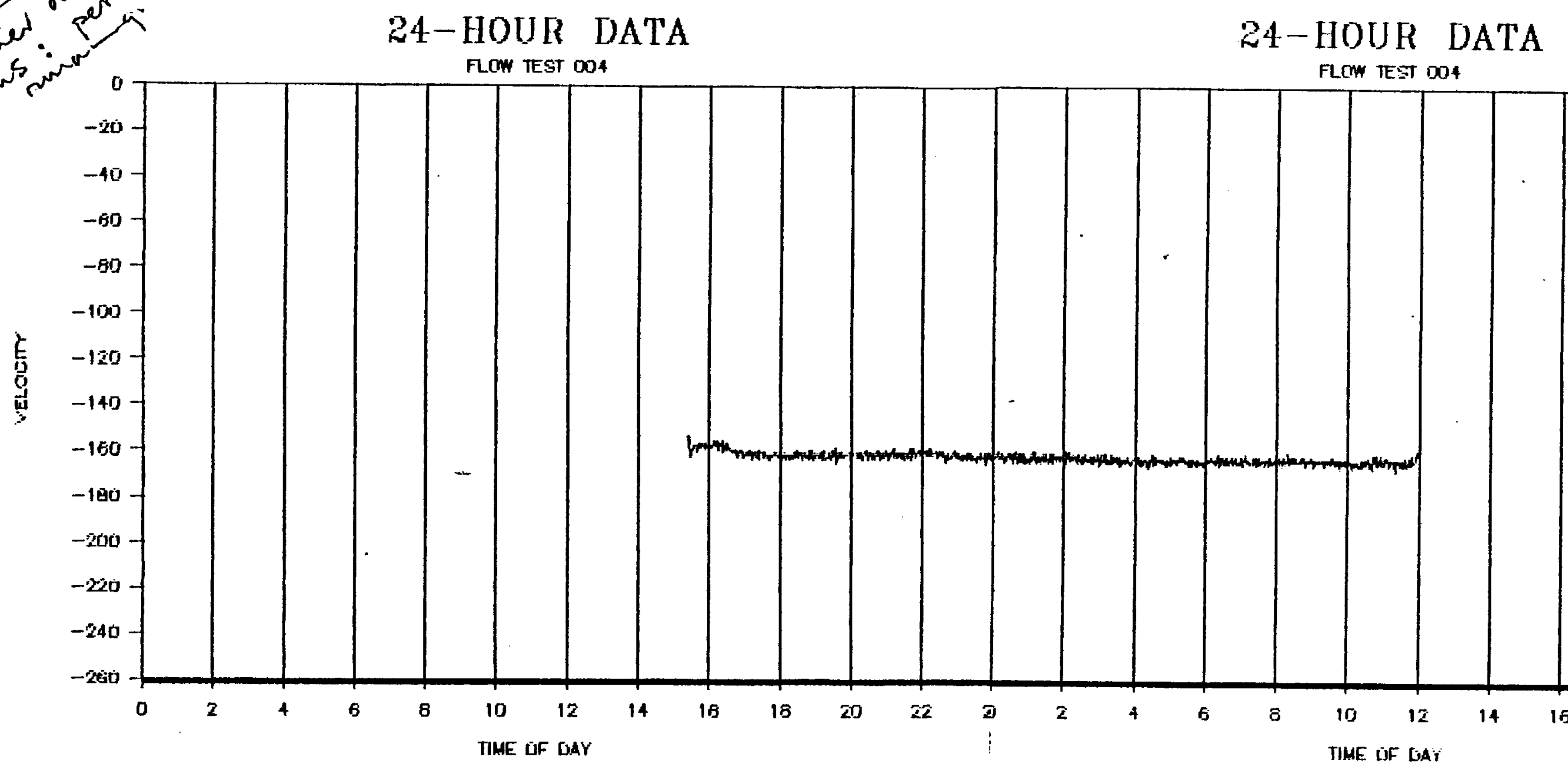
May 5
light above
condenser, Pumping
water overflow back
into reservoir, ie head.
constant secondary
Another diff from
prev runs: peristaltic
pump? running

Fig. 3
24 hour velocity data from Dunaliella



Prize for best looking data,
but see summary stats from
the first six hours + →

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Nearer normal

Variable:	VEL0	VEL1	VEL2
Sample size	1658	1757	1890
Average	-162.039	-162.306	-162.547
Median	-162.312	-162.312	-162.312
Mode	-161.547	-163.078	-163.078
Geometric mean			
Variance	39.0124	37.563	36.1619
Standard deviation	6.24599	6.12886	6.01348
Standard error	0.153394	0.146216	0.138323
Minimum	-185.281	-184.515	-182.219
Maximum	-127.859	-137.813	-141.641
Range	57.4219	46.7029	40.5785
Lower quartile	-166.14	-166.14	-166.907
Upper quartile	-157.719	-158.484	-158.484
Interquartile range	8.4217	7.6563	8.4226
Skewness	0.190437	0.197301	-0.0216271
Standardized skewness	3.16568	3.37628	-0.383844
Kurtosis	0.553595	0.325558	-0.0216545
Standardized kurtosis	4.60128	2.78553	-0.192164

Variable:	VEL3	VEL4	VEL5
Sample size	1857	1926	2096
Average	-163.34	-163.527	-163.456
Median	-163.078	-163.844	-163.844
Mode	-162.312	-161.547	-163.844
Geometric mean			
Variance	38.1946	41.748	37.9794
Standard deviation	6.18018	6.46127	6.16274
Standard error	0.143415	0.147228	0.13461
Minimum	-196	-189.109	-181.453
Maximum	-139.343	-140.875	-139.343
Range	56.6564	48.2338	42.1094
Lower quartile	-167.672	-167.672	-167.672
Upper quartile	-159.25	-159.25	-159.25
Interquartile range	8.4217	8.4217	8.4217
Skewness	0.112429	0.0842093	0.167328
Standardized skewness	1.97791	1.50873	3.12743
Kurtosis	0.561965	0.316777	0.0616489
Standardized kurtosis	4.94322	2.83777	0.576123

Fig. 3A
Summary statistics of one hour periods
from data set 004

Summary
Test 004
00:00 – ~~06:00~~ 06:59

Prepared from raw data on 5/4.
Show awesome variations in Std. skewness and kurtosis +

Means and σ's are indeed v stable but this aint normally dist. data!!

Why?

- Could be the arbitrary treatment of pm volts v gain, explored on ev. of 5/13.

Therefore switch to a study of data from that file.

- Could be the "windows" we have been using Cutoff at 500μ but this seems unlikely, even though the skew is generally toward

IS THERE SOME INSTRUMENTAL ARTIFAC OR SAMPLING ARTIFACT WHICH WE ARE STILL MISSING?

Variable:	VEL6
Sample size	2202
Average	-163.21
Median	-163.078
Mode	-163.078
Geometric mean	
Variance	38.9447
Standard deviation	6.24057
Standard error	0.132989
Minimum	-183.75
Maximum	-139.343
Range	44.4066
Lower quartile	-167.672
Upper quartile	-159.25
Interquartile range	8.4217
Skewness	0.0855942
Standardized skewness	1.63975
Kurtosis	0.171419
Standardized kurtosis	1.64196

Fig. 3B
Summary statistics from 004 continued

of 24 hour velocity data (Fig. 3). The stability suggested stochastically stationary data and a chance to use ANOVA's with repeated measurement, an analytical technique which Ed May had recommended and described in detail. Unfortunately a more careful examination of the data showed that while the mean velocities were constant to better than 1% throughout, the higher statistical moments varied all over. Figs. 3A and 3B give the details: the handwritten marginal notes reflect our thinking at that time. The same general pattern prevailed in repeat runs, and it was evident that these data would not be suitable for a pk vs IDS analysis.

At this point we acquired a new SD382 0-40KHz signal analyzer for the BLD spectroscopy project. Using it, we began to search for artifacts and instrumental problems. Studying the oscillators in the Dantec tracker, we found that the shift frequency which Dantec had quoted as 5.500 KHz drifted from 5.56X to 5.58X KHz. The time scale of the drift was much longer than that of a set of psi trials. However, we modified our procedures to calibrate, prior to each set, largely because this insured the correct sign on the data (up or down motion). At the same time, we upgraded the precision of our raw data by changing the data processing route from the 8-bit Dantec tracker to a 12 bit A/D board. The overall result was to increase the precision of the velocity measurements by a factor of 16. Also, percent positive (or percent swimming downward) became a useful, unambiguous, binomial statistic which could be examined for psi-induced changes independent of the value of the velocity.

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Fig. 4 shows overnight data from the system. This general pattern was replicable, and little different from that obtained earlier with our less accurate apparatus. On inspection, some portions of the time series data appeared relatively normally distributed. Most showed widely varying skew and kurtosis. We hope that this kind of biologically active data will help SRI with their pk vs IDS studies, but we have serious doubts. We are confident that the data reflect what is really going on in the culture.

Fig. 4 shows a layout of the environmental chamber and laboratory. Two sets of experiments were conducted with the intention of providing the best possible data for SRI to use for hypothesis-testing:

Set 1 psi runs using a modification of the WAVE protocol[3], with sets of five trials at each of three sequence lengths. 5, 15 and 40 averages of 100 raw data were chosen after discussions with Ed May[4]

Set 2 parallel runs in which a 5000 VDC spark source within the environmental chamber provided a low level "real"

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3 Pleass, C. M. and N. D. Day, "Behavioral response of marine microorganisms to psi stimulus: statistical analysis of data from Dunaliella," Proc. 29th Annual Conv. Parapsych. Soc., Sonoma State Univ., CA (5-9 Aug. 1986).

4 SRI originally asked that the duration of the trial be hidden from the participant, i.e. all would appear to have the duration of the longest. CMS missed this point and apologize. If the data are useful in other respects, we would be pleased to repeat the sets at no cost to SRI.

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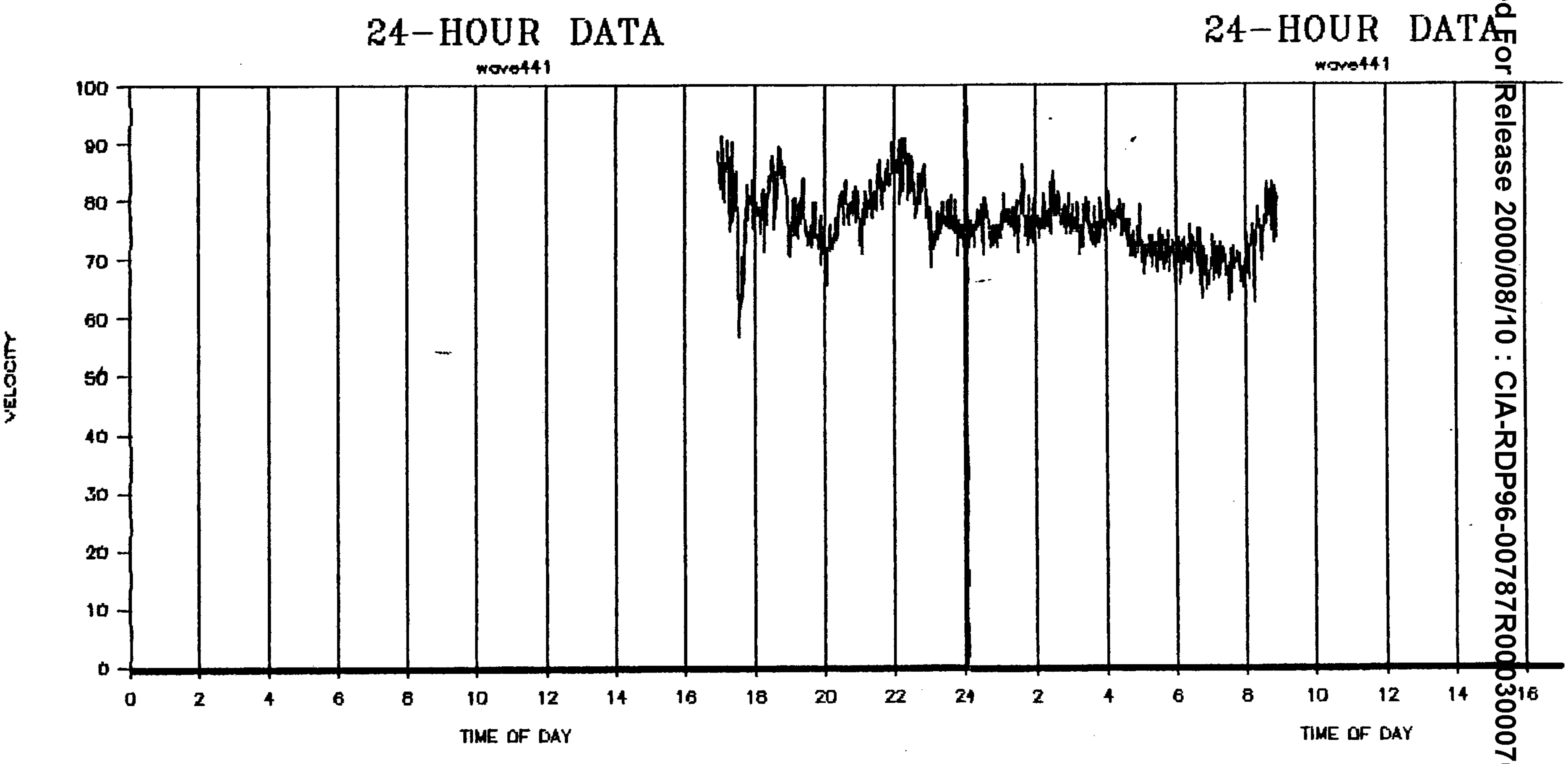

Fig. 4 Overnight data from the flow system after upgrading to 12 bit data transfer

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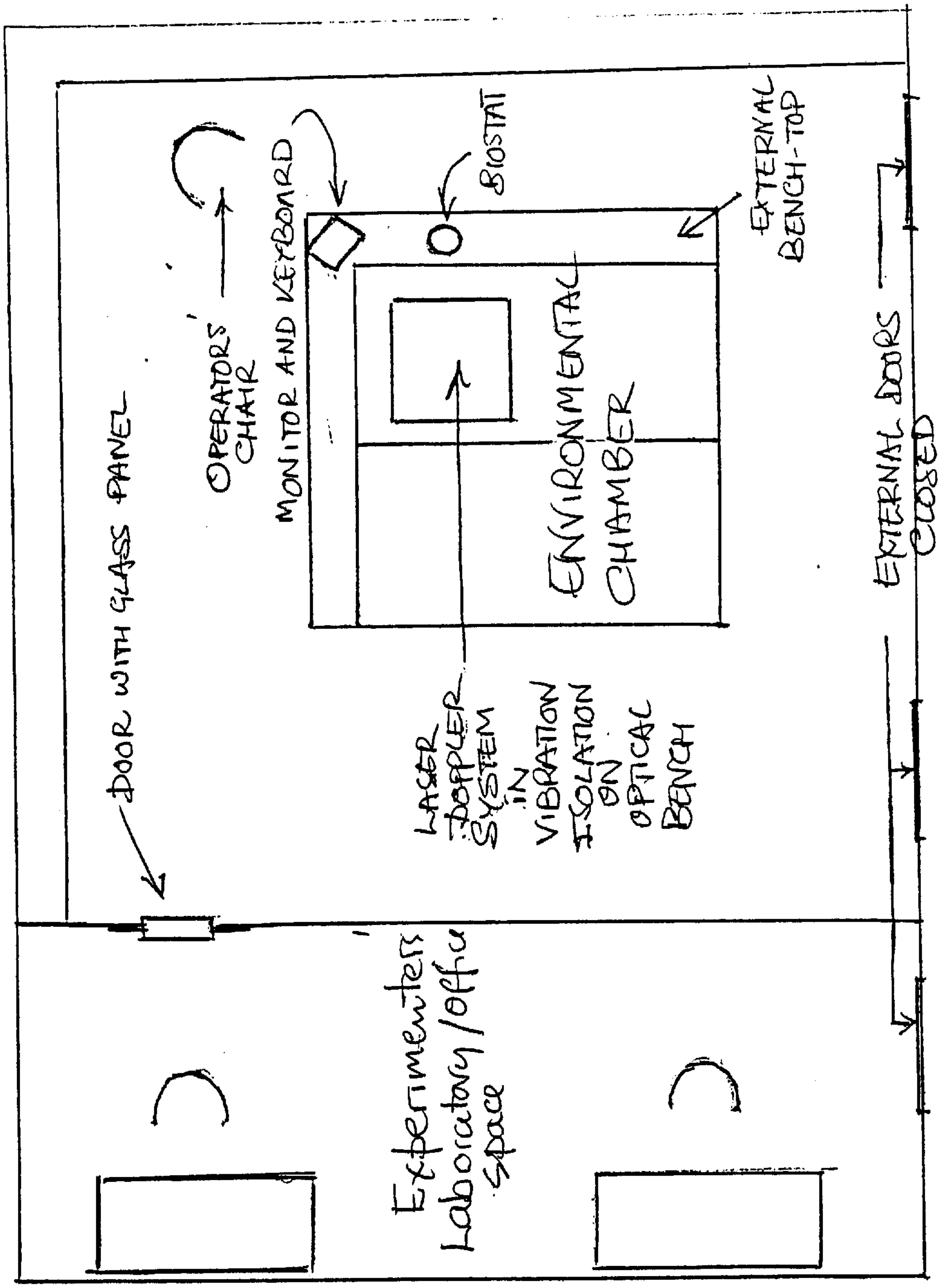

Fig. 5
Lay Layout for SRI PSI Experiments

(sonic, optical and E.M.) stimulus for comparative statistical analysis.

Format for the Experiments

The "WAVE" protocol is a technique for examining the release of psi pressure. Its general characteristics are:

- Continuous time series data beginning several hours prior to the psi run.
- Participants "warm up" at their own pace, prior to a trial.
- The participant makes one button push, to mark the end of the psi period.
- A space between trials at least 4X the data content of the preceding psi period.

Detail of the modifications used to carry out the SRI work follow:

1) Electronics are turned on the evening before a run. If overnight data is to be collected, three hours will subsequently be deleted from the time series to cover the warm-up and stabilization of the oscillators.

2) Data routing: Photomultiplier → tracker, for removal of 40 .MHz shift → 12 bit A → D conversion → PC → identification of status (predata, psi, control, etc.) by a file marker.

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3) <u>Data processing</u>: PC → raw velocities and up/down information (± sign on the raw data) → means of 100 raw velocities, and percent moving down. Store this. One line of the file will then read: Record #, time, av. velocity, std. deviation, % positive, Marker

4) Definition of file markers:

    0 - unassigned
    666 - Button-push at end of psi period
    888 } Historic, pseudopsi and pseudo control
    777 } markers of no utility for SRI work

5) Approximately one hour before the participant arrives the experimenter will break the predata collection, check the actual shift frequency using the SD380, and restart the control program with the new value added. (Normally changes are very slight after the warm up period, and the time for detectable change is long compared to the duration of a set of psi trials). The participants' ID number, data, and the initial number of points per trial will be added at this time. The screen will be left ready for the participant with the instruction

Press F1 to mark end of trial

Trial X coming up!

6) The participant will be seated by the keyboard and monitor outside the environmental chamber. They can be observed by the experimenter through a glass panel in a connecting door (Fig. 4). They have been

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encouraged to take whatever time they personally feel that they need to get into a psi-conducive state prior to each button push. They are motivated to keep this period short, because we ask that they perform at least five trials at each of three sequence lengths. When they become aware of a period of peak performance they are instructed to press F1 (which marks the data file) and abruptly break out of the psi mode[5]. The monitor screen turns from grey to blue at the button press. During the blue screen interval they are asked to read a dictionary. When the screen returns to grey they may try again.

7) After five or more trials at the first sequence length (500 raw data points), the participant uses a menu to change to the next sequence length. A 5 x 500, 5 x 1500 and 5 x 4000 experiment normally takes on the order of 2-2 1/2 hours.

Discussion of the Experimental Format

- There may be an inevitable restriction on producing BLD data for a comparison of psi and IDS hypotheses. Our observation is that the psychological state of the participant tends to change as the set progresses. They may become more psi-competent or less, and we can see no way to quantify this or eliminate its effect,

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[5] We feel that the act of becoming aware of deep involvement is in itself a sign that the period has ended.

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unless a large data base were developed from sets where sequence length was chosen at random. We can do this; however, if the identity of the trial is to be hidden from the operator by constantly using the longest spacer, it may be desirable to reduce the length of the longest sequence. Our experience to date suggests that 100 trials at a sequence length of 40 would take circa 35 participant hours.

- No immediate feedback was provided during the trials whose results are reported below. Our participants do not like watching the monitor during the run, and we have not yet found an appropriate way of reflecting their performance. After the experiment is complete the participant is debriefed. The experimenter notes their comments and adds his own. As soon as we can settle on a "real time" analytical procedure that we can use to present the results of the experiment we will do so, but at present the analytical procedure requires transferring the time-series data to Lotus for processing. Results are mailed to the participants, usually within one week.

- Although the participant is aware of the progression to longer sequence lengths this does not directly affect the length of time they spend working into a psi-conducive state. The reason that everyone gives for preferring the WAVE protocol is that they need not "work by the clock". The time series data which reflect their effort generally contains several times the number of data points required for the analysis.

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Results

Four participants completed sets in the format previous described. One set of data was developed in the same format using a distant spark as a low level "real" stimulus.[6] The experimenter switched on the spark when the grey screen appeared (the equivalent of beginning to get into a psi-conducive state) and switched it off again one minute later, pressing F1 at the same time. The various files are identified in the cover letter which was shipped to SRI with the data on 9/14/87, and a copy of this is attached for completeness as Appendix 1.

We routinely check the summary statistics from random samples from pre-data strings once the data have been transferred to Lotus. Since the raw data have been shipped to SRI we will only report our general conclusion: that very few sample periods contain data which even approximate a normal distribution. The 8000 point data set sent to Ed May prior to the January meeting is, ironically, one of the best approximations to a normal distribution. We solemnly swear that this was by chance and not by intent (!).

Because the baseline distributions were not generally normal we chose to examine the psi and control periods using the non-parametric two sample Kolmogorov and Smirnov test. This has the additional practical advantage of presenting a graph of cumulative

6 Two other "spark runs" were carried out, but not sent to SRI since power failures took out the predata. We would appreciate feedback before repeating these experiments, since it seems as though a more intense "real" stimulus would be better.

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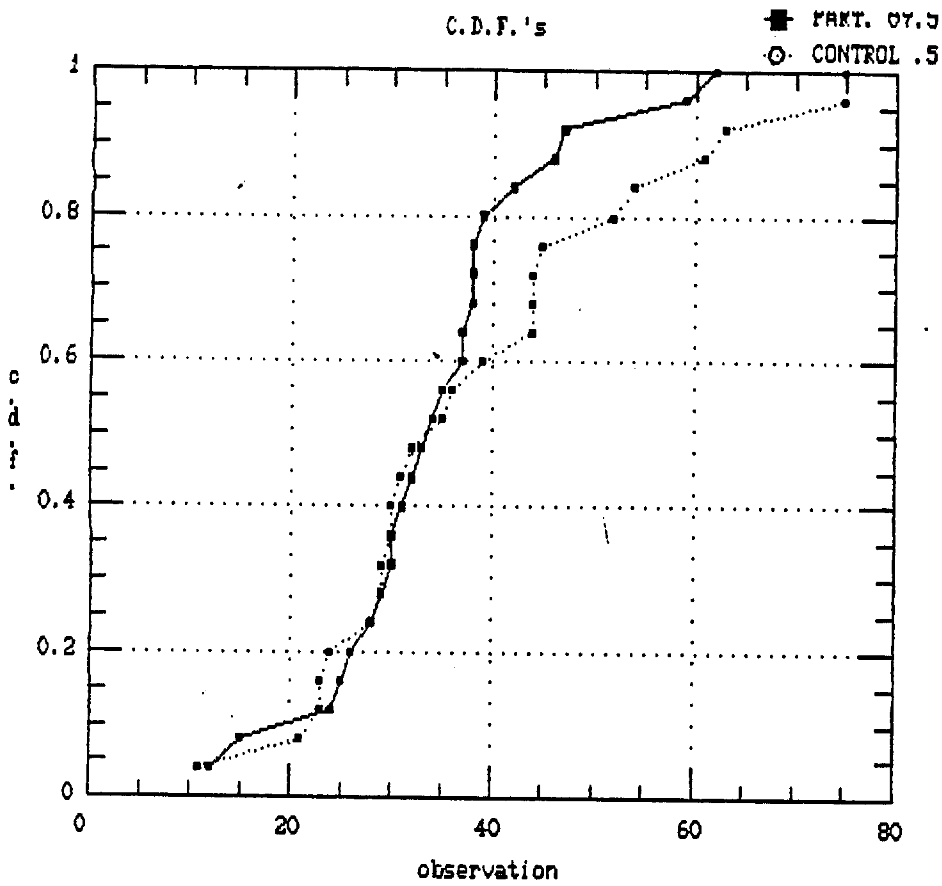


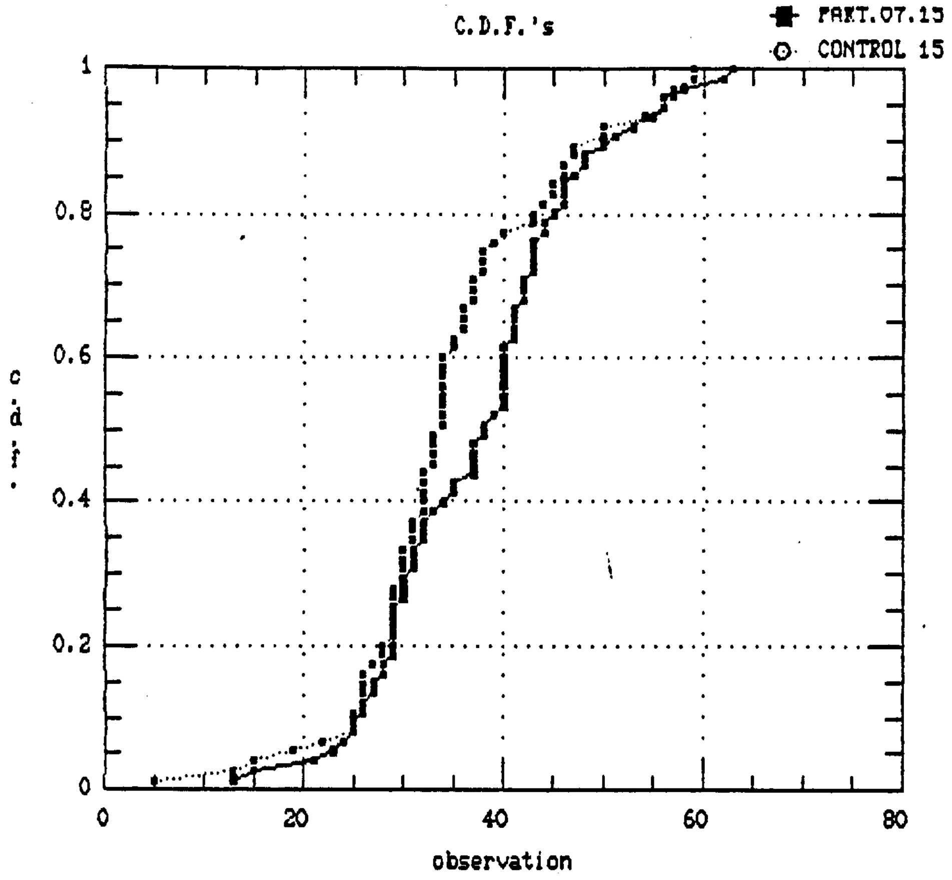
Kolmogorov-Smirnov Two-Sample Test

Sample 1: P:OP7.pos5 SELECT P:OP7.mark5 EQ 666

Sample 2: P:OP7.pos5 SELECT P:OP7.mark5 EQ 999

Estimated overall statistic DN = 0.24
Approximate significance level = 0.467558

Fig. 6
Participant 7, %+ve data.
Sequence length 500 raw data points.



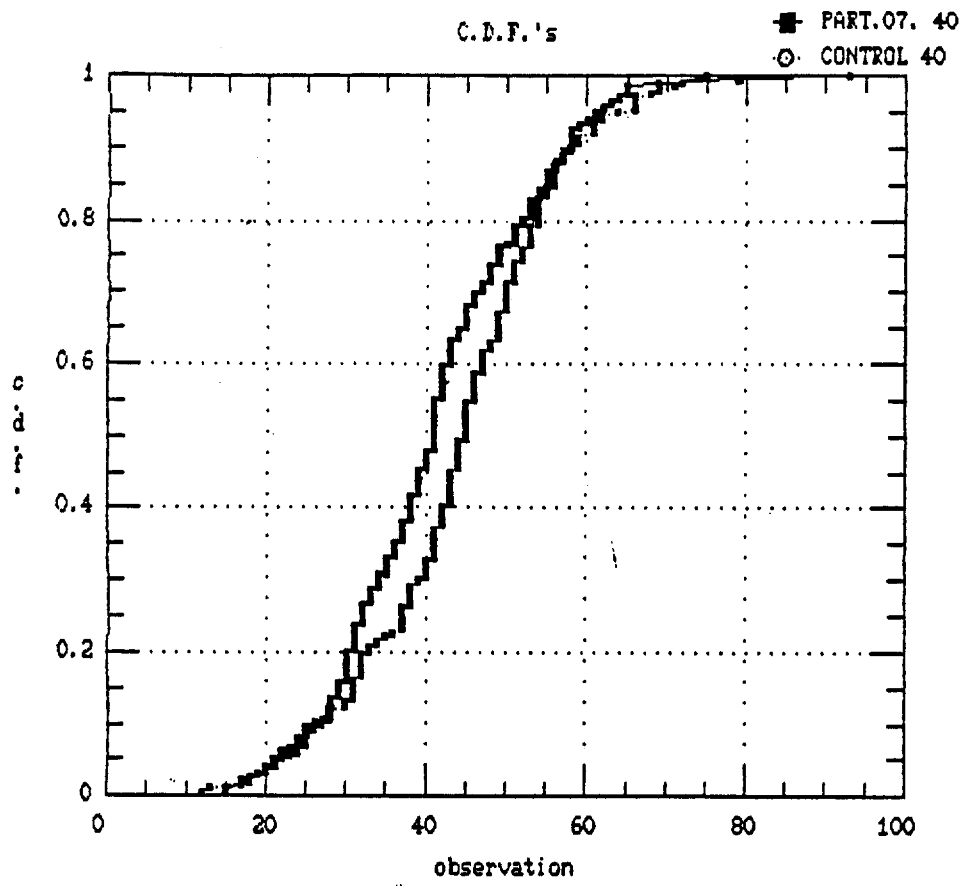
Kolmogorov-Smirnov Two-Sample Test

Sample 1: P:OP7.pos15 SELECT P:OP7.mark15 EQ 666

Sample 2: P:OP7.pos15 SELECT P:OP7.mark15 EQ 999

Estimated overall statistic DN = 0.32
Approximate significance level = 9.2395E-4

Fig. 7
Participant 7, %+ve data.
Sequence length 1500 raw data points.



Kolmogorov-Smirnov Two-Sample Test

Sample 1: P:OP7.pos40 SELECT P:OP7.mark40 EQ 666

Sample 2: P:OP7.pos40 SELECT P:OP7.mark40 EQ 999

Estimated overall statistic DN = 0.195
Approximate significance level = 9.95911E-4

Fig. 8
Participant 7, %+ve data.
Sequence length 4000 raw data points.

Kolmogorov-Smirnov Two-Sample Test

Sample 1: T:GLOBO7.pospre5 SELECT T:GLOBO7.mark5 EQ 666

Sample 2: T:GLOBO7.pospre5 SELECT T:GLOBO7.mark5 EQ 999

Estimated overall statistic DN = 0.16
Approximate significance level = 0.999999

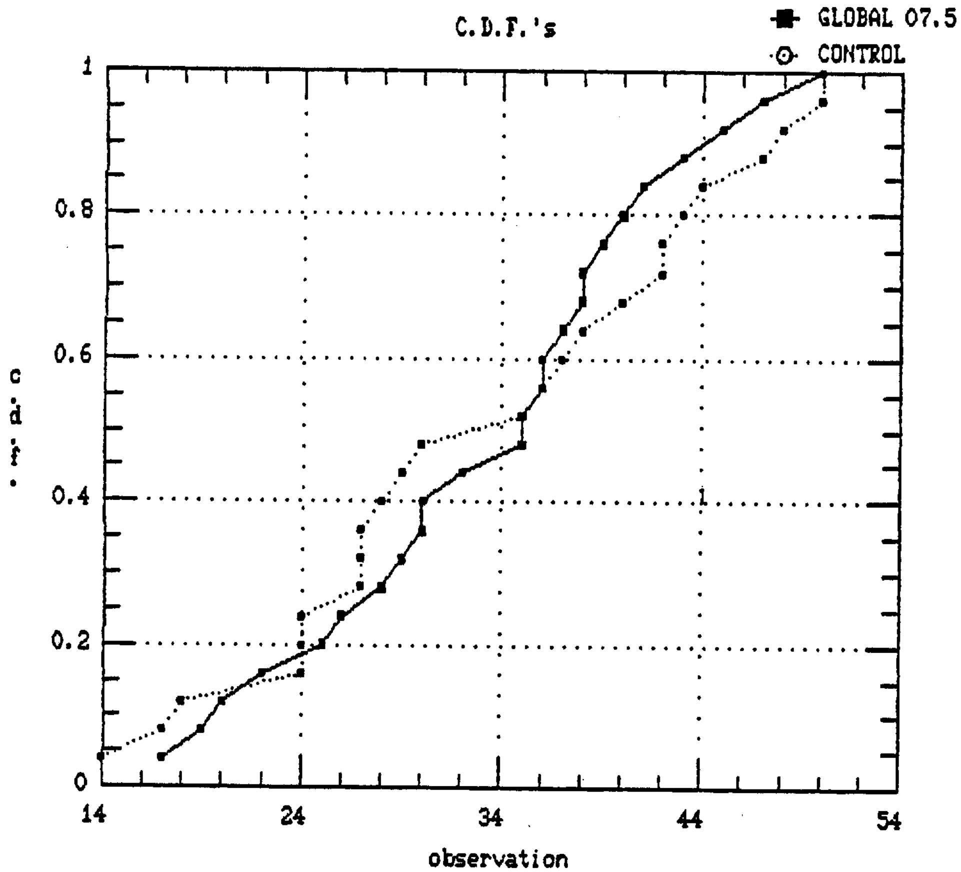


Fig. 9
Global control from predata file
for Participant 7, %+ve, 500.

Kolmogorov-Smirnov Two-Sample Test

Sample 1: T:GLOB07.pospre15 SELECT T:GLOB07.mark15 EQ 666

Sample 2: T:GLOB07.pospre15 SELECT T:GLOB07.mark15 EQ 999

Estimated overall statistic DN = 0.146667
Approximate significance level = 0.395295

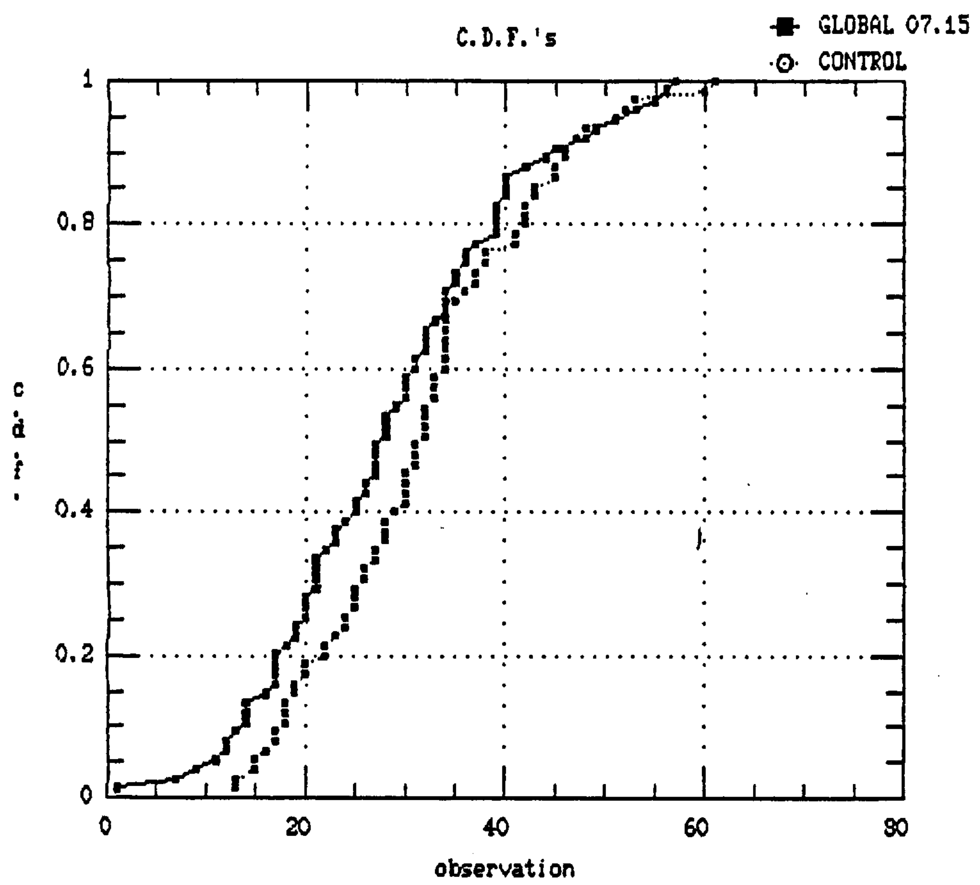


Fig. 10
Global control from predata file,
for Participant 7, %+ve, 1500.

Kolmogorov-Smirnov Two-Sample Test

Sample 1: T:GLOBO7.pospre40 SELECT T:GLOBO7.mark40 EQ 666

Sample 2: T:GLOBO7.pospre40 SELECT T:GLOBO7.mark40 EQ 999

Estimated overall statistic DN = 0.12
Approximate significance level = 0.11225

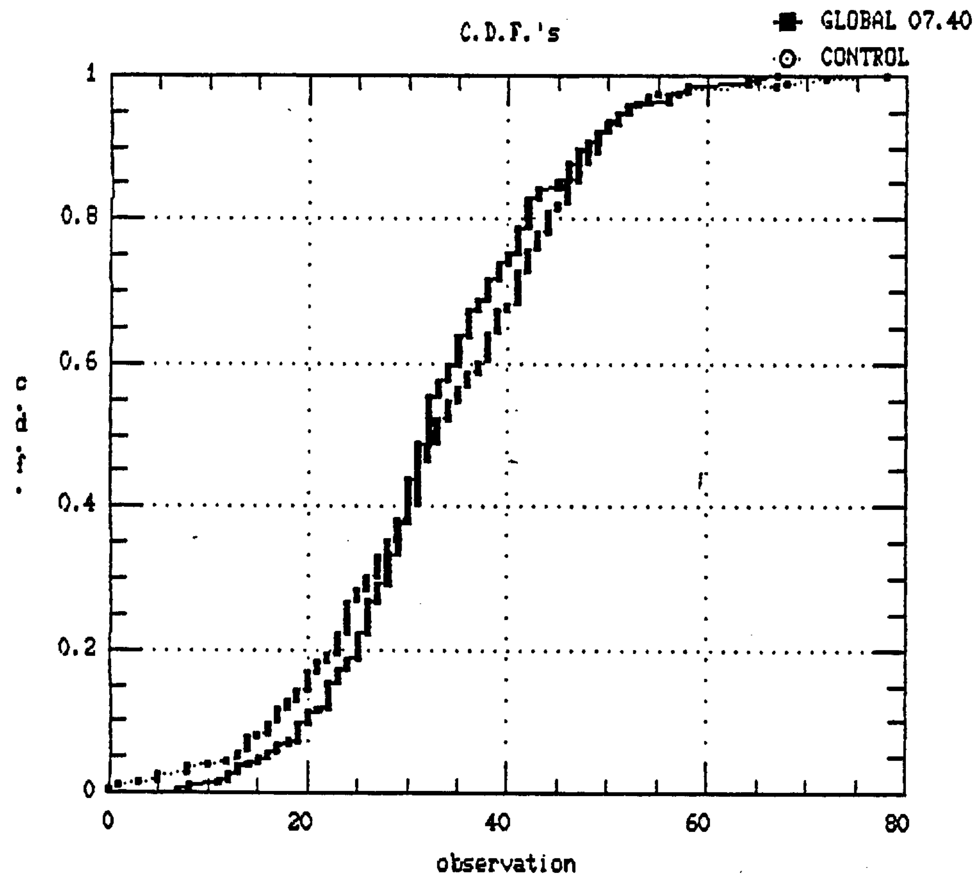


Fig. 11
Global control from predata file,
for Participant 7, %+ve, 4000.

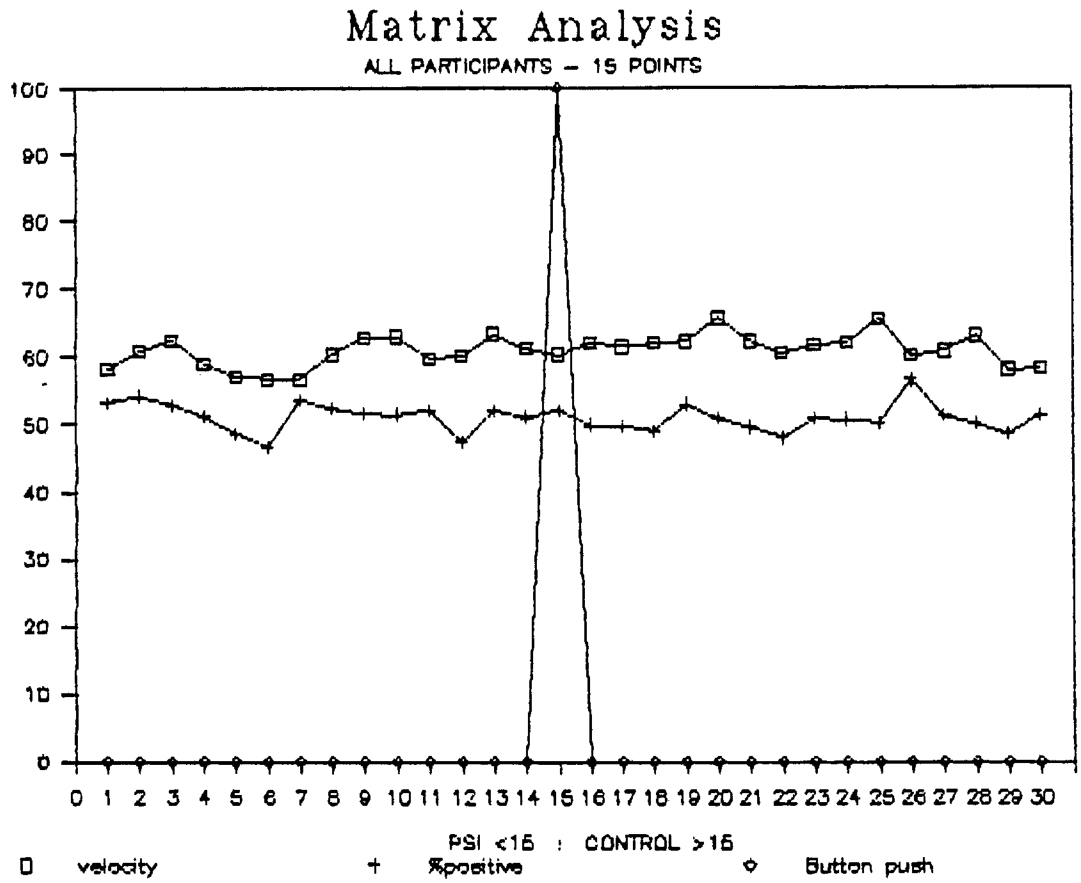


Fig. 12
Averages by column.
All files for 40 and 15 data point trials.
Datum $\pm$ 15 points.

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Kolmogorov-Smirnov Two-Sample Test

ample 1: V:MATRIX15.velocity SELECT V:MATRIX15.marker EQ 666

ample 2: V:MATRIX15.velocity SELECT V:MATRIX15.marker EQ 999

stimated overall statistic DN = 0.131532
pproximate significance level = 1.35214E-4

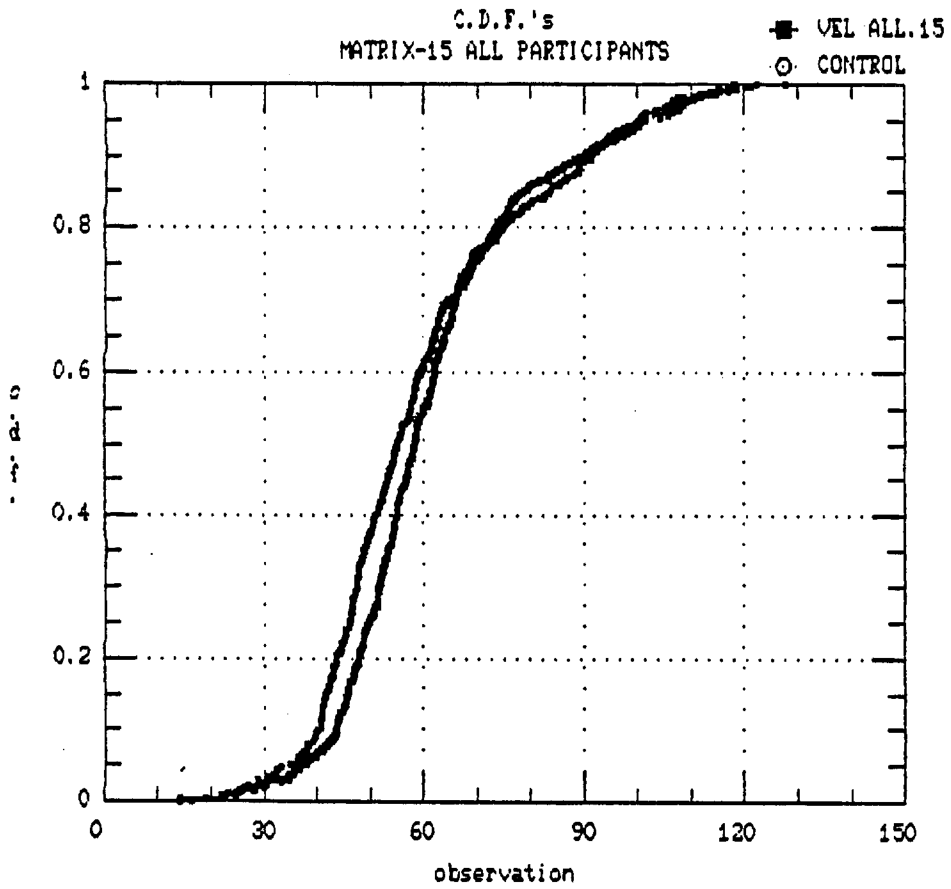

Fig. 13
All participants.
Average of 40 and 15 data point trials.
Datum ± 15 points.

Kolmogorov-Smirnov Two-Sample Test

Sample 1: V:MATRIX15.positive SELECT V:MATRIX15.marker EQ 666

Sample 2: V:MATRIX15.positive SELECT V:MATRIX15.marker EQ 999

Estimated overall statistic DN = 0.0792793
Approximate significance level = 0.0611045

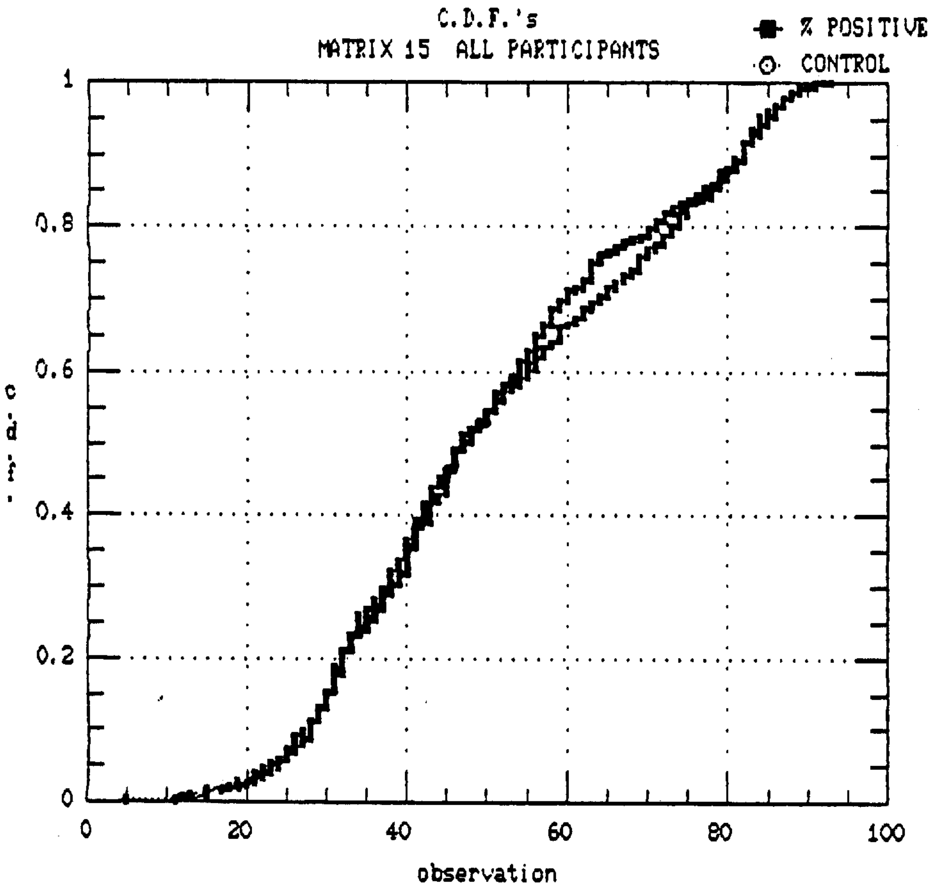

Fig. 14
All participants.
Average of 40 and 15 data point trials.
Datum $\pm$ 15 points.

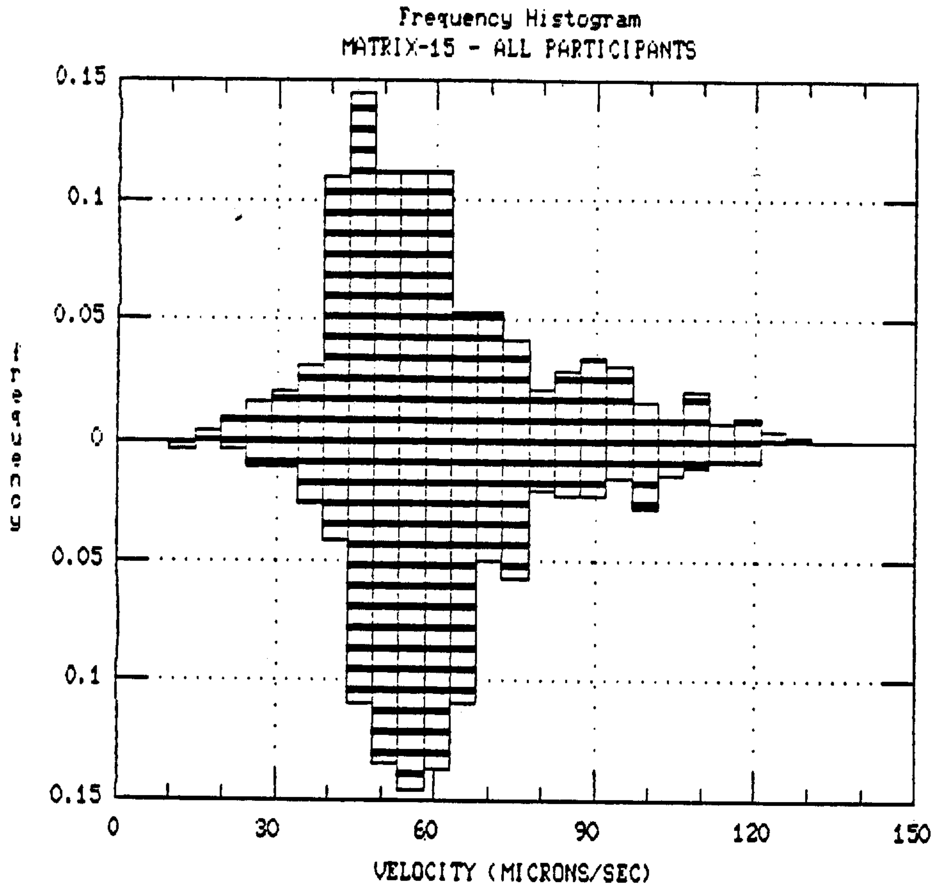

Fig. 15
Average of 40 and 15 data point trials.
Datum $\pm$ 15 points.

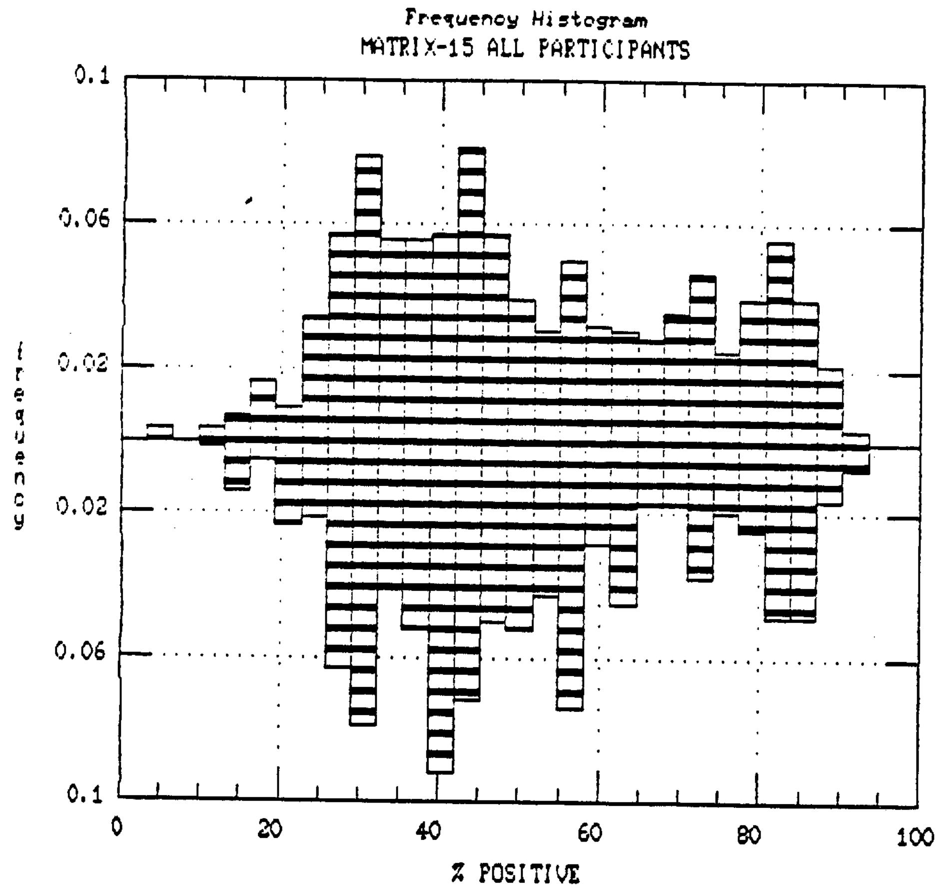

Fig. 16
Average of 40 and 15 data point trials.
Datum $\pm$ 15 points.

Kolmogorov-Smirnov Two-Sample Test

Sample 1: V:GMATRIX.gvel15 SELECT V:GMATRIX.gmark15 EQ 666

Sample 2: V:GMATRIX.gvel15 SELECT V:GMATRIX.gmark15 EQ 999

Estimated overall statistic DN = 0.0747967
Approximate significance level = 0.0640856

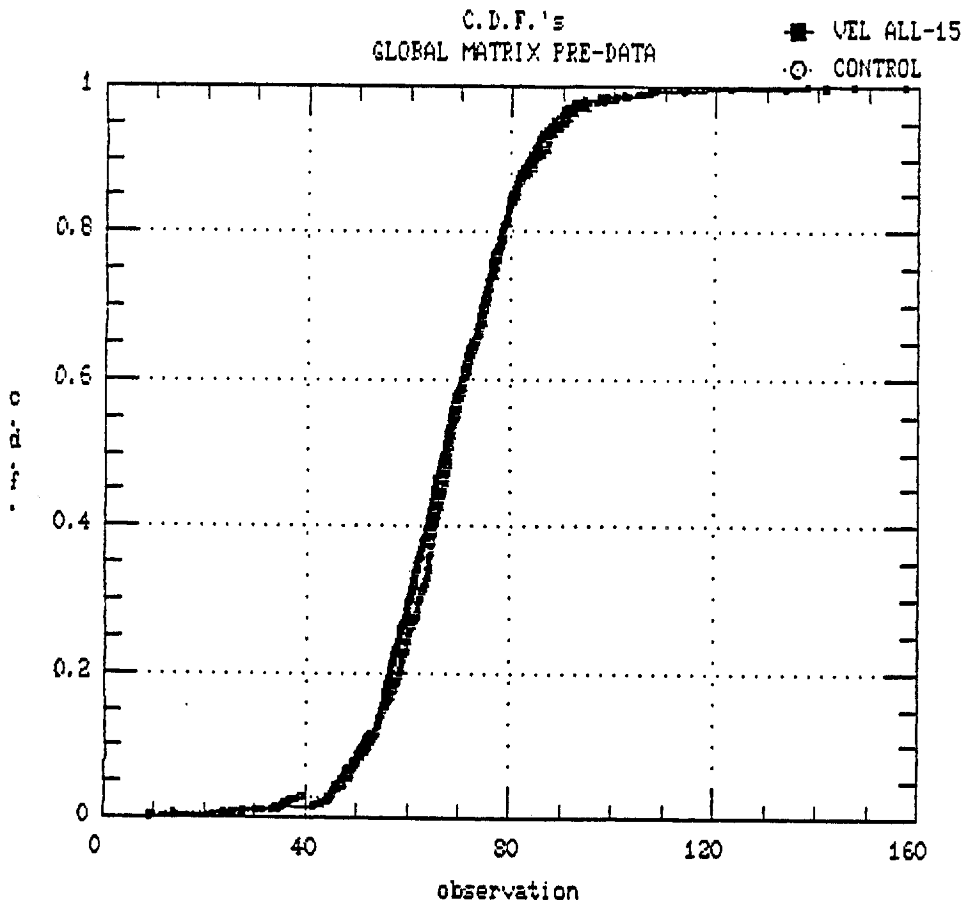

Fig. 17
Global control. All participants.
40 and 15 data point trials.
Datum ± 15 points.

Kolmogorov-Smirnov Two-Sample Test

Sample 1: V:GMATRIX.gpos15 SELECT V:GMATRIX.gmark15 EQ 666

Sample 2: V:GMATRIX.gpos15 SELECT V:GMATRIX.gmark15 EQ 999

Estimated overall statistic DN = 0.0666667
Approximate significance level = 0.129969

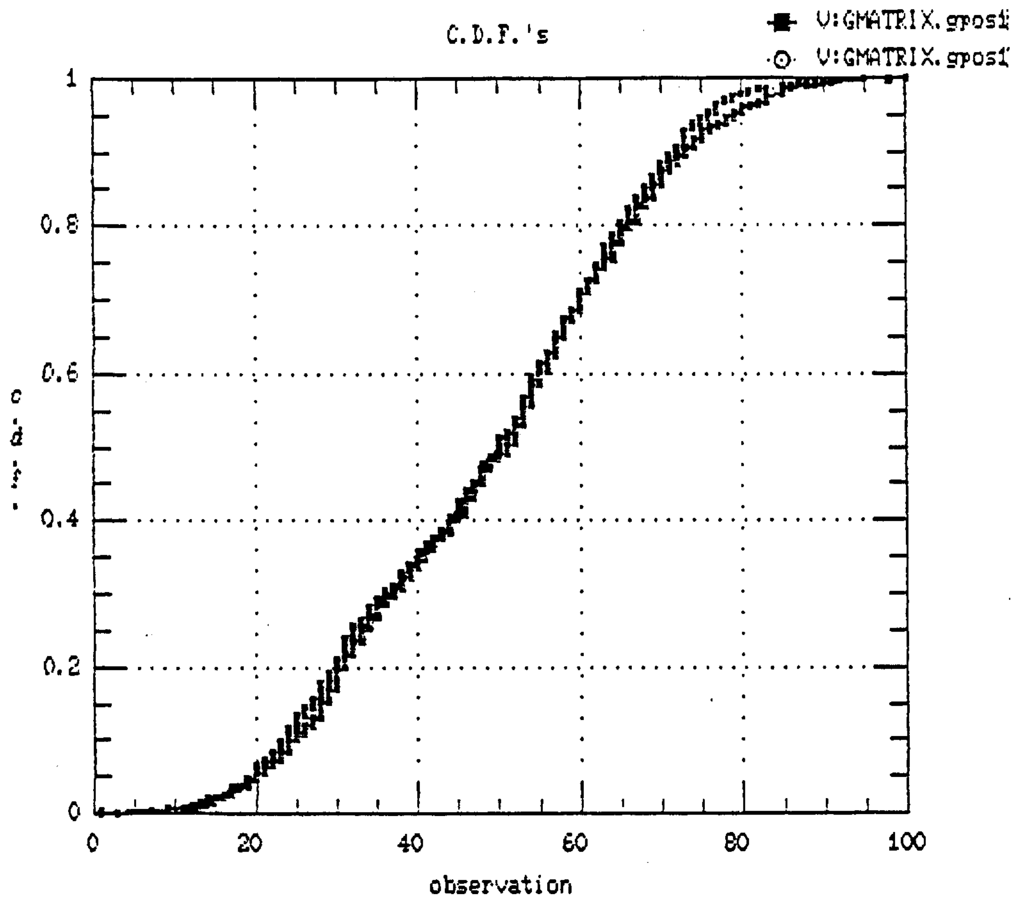

Fig. 18
Global control. All participants.
40 and 15 data point trials.
Datum ± 15 points.

APPENDIX 1

Description of Data on Discs Sent to SRI on 15 September 1987

September 14, 1987

SUMMARY OF WAVE 1987 PROTOCOL

The Wave protocol allows a participant to become involved in a trial at their own speed. When the participant recognizes that they are fully involved in the experiment (i.e., they emerge from the state of complete involvement momentarily), they end the trial by pressing the F1 key. This places a 666 in the marker field, identifying the end of the psi period and the beginning of the period which we call control. Please note that the involvement of the participant is normally substantially longer than that required by the analytical protocol. At the end of the control period a random spacer is placed in the data files, followed by a Pseudo-psi and Pseudo-control trial. An additional longer spacer period is then added before another trial is allowed to begin. Note that although the pseudo-trials are historic remnants (we could have deleted the markers for you), we have experimental evidence that if the algae are stimulated by some "real" source such as a spark, returning to the baseline condition requires a period at least 2 - 3 times the duration of the stimulus. The total interval therefore defines a trial period appropriate for experiments which address a comparison of psi and spark data.

The data files consists of ASCII records written in a Sequential file, recorded as the data are collected. Each record consists of 6 fields, each field is separated by a comma.

Each data record consists of the following fields:

Record #, Time, Average Velocity, Standard Deviation, % Positive, Marker

All data used are the absolute value (i.e., sign is ignored except in the calculation of % positive). Each recorded velocity field (#3) of each record is in reality the mean of 100 individual raw absolute velocities. The standard deviation field (#4) is calculated using the raw absolute velocities.

The % Positive field (#5) records the number of raw velocities which were positive during the collection of the 100 raw data points.

The Marker field (#6) has the following codes:

0 - Unassigned Period

666 - Button Push at end of psi Period
999 - Control Period

888 - Pseudo-psi Period

777 - Pseudo Control Period

All non-zero Marker periods are of the same length. The 666 marker indicates the END of the psi period, as this point is of unknown prior to the decision of the participant.

At the beginning of the set, the number (N) of records to be collected in each trial is selected. To analyze the data, this number used to delineate the psi period. This is not yet programmed in: one must go back to the data files and add (N-1) 666 marker records prior to each existing 666 marker.

The data are on IBM AT 1.2 MB floppies. The filename format is:

WAVExxxx.dat

where xxxx represents the filenumber shown below.

Test #	**#/Trial**	**PreData File**	**PostData File**
Participant 5			
358	5		
353	15	353	359
357	40		
Participant 7			
419	5		
420	15	417g	---
421	40		
Participant 48			
408	5		
409	15	406	411
410	40		

Participant 17

440	5		
439	15	437	441
438	40		

<u>Spark</u>

412	5		
413	15	411e	417
414	40		
415	5		

The directory structure is:

DISK 1:

```
ROOT ──────── PART ──┬──────── OP05
                     ├──── OP07
                     ├──── OP48
                     ├──── SPARK
                     └──── OP17 ──────┬──── PRE
                                      └──── POST
```

DISK 2:

```
ROOT ──────── PART ──┬──── OP05 ──────┬──── PRE
                     │                └──── POST
                     ├──── OP07 ────────────── PRE
                     ├──── OP48 ──────┬──── PRE
                     │                └──────── POST
                     └──── SPARK ─────┬──────── PRE
                                      └──── POST
```